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(21) International Application Number: PCT/US99/03698 (22) International Filing Date: 19 February 1999 (19.02.99) (30) Priority Data: 60/075,352 20 February 1998 (20.02.98) US (71) Applicant (for all designated States except US): TEXTILE BIOCIDES, INC. [US/US]; 622 Spruce Street, Philadelphia, PA 19106 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): KRUPNICK, Steven [US/US]; 622 Spruce Street, Philadelphia, PA 19106 (US). SCHAPIRO, Saul, A. [US/US]; 1478 Hollow Road, Bichrunville, PA 19421 (US). (74) Agents: SHAPIRO, Mitchell, W. et al.; Vorys, Sater, Seymour and Pease LLP, 11th floor, 1828 L Street N.W., Washington, DC 20036 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: ANTIMICROBIAL TREATMENT OF CURRENCY PAPER (57) Abstract An antimicrobial currency paper web is prepared by applying to the currency paper web an amount of chlorhexidine, polymethylene biguanide, or salt thereof effective to render said paper web antimicrobial. The currency paper so prepared is effective in inhibiting spread of infectious diseases when paper currency is exchanged by hand.		

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TITLE: ANTIMICROBIAL TREATMENT OF CURRENCY PAPER

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to antimicrobial treatment of cellulosic materials and more particularly to the treatment of currency paper to render it antimicrobial.

5 Brief Description of the Prior Art

Paper currency typically becomes contaminated with microorganisms from being handled and exchanged in commerce. Accordingly, pathogenic microorganisms can be readily spread from person to person simply by handling paper money in the
10 everyday transactions required in daily life. Consequently, paper money can be a means of transmitting diseases caused by microorganisms, and, in particular, can be an agent for the spread of epidemic and pandemic diseases. Furthermore, the possibility of deliberate contamination of paper money
15 with infectious microbiological agents as a form of biological warfare or terrorist activity has caused concern among public health officials.

Antimicrobial agents have been applied to non-woven products used as wet wipes in order to impart antimicrobial
20 properties. U.S. Patent 4,837,079, to Quantrille et al., the entire disclosure of which is incorporated herein by reference, discloses a process for providing wet wipes having antimicrobial properties by treating an unbonded

fibrous web with a binder and polyhexamethylene biguanide as an antimicrobial agent and subsequently curing the binder to form an antimicrobially active non-woven web. However, Quantrille does not disclose making an antimicrobial paper product, in particular, a currency paper product, having antimicrobial properties.

Accordingly, a need has continued to exist for a method of providing paper money with antimicrobial properties in order to reduce or prevent cross contamination of bacteria, etc., from person to person by handling of contaminated currency.

SUMMARY OF THE INVENTION

The problem of providing antimicrobial paper currency has now been alleviated by the method of this invention wherein paper used in manufacture of paper currency is impregnated with an antimicrobial agent substantive to the currency paper.

Accordingly, it is an object of the invention to provide a method for imparting antimicrobial properties to paper currency.

A further object is to provide a method of imparting permanent antimicrobial properties to paper currency.

A further object is to treat currency paper to protect against microbial cross contamination of bacteria and other microorganisms from person to person by handling money.

A further object is to provide paper currency having antimicrobial properties.

A further object is to provide a paper currency having permanent antimicrobial properties.

5 A further object is to provide a method for decreasing the spread of infectious diseases by exchange of paper currency.

Further objects of the invention will become apparent from the description which follows.

10 DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENTS

According to the invention an antimicrobial paper currency product is prepared by incorporating into currency paper an amount of an antimicrobial compound effective to kill or inhibit the growth of pathogenic microorganisms such
15 as bacteria, fungi, viruses, and the like, that come into contact with the paper.

Any conventional antimicrobial compound that is stable in contact with cellulosic materials and substantive to the cellulose therein may be used in the method of the
20 invention. Preferred compounds are those that exhibit a long-lasting antimicrobial effect in commercial products. Suitable antimicrobial compounds include chlorhexidine and polyhexamethylene biguanide. These compounds may be used as any conventional salt, preferably a salt sufficiently
25 soluble in water to permit application of an effective amount of the antimicrobial compound as an aqueous solution.

Such salts include the hydrochloride, hydrobromide, gluconate, and the like. A preferred antimicrobial compound is polyhexamethylene biguanide (PHMB) sold, as the hydrochloride salt, under the trademark REPUTEX® by Zeneca Biocides, and which is registered with the United States Environmental Protection Agency under Registration No. 10182-128 as a pesticide. It is currently used in over 300,000 swimming pools as a replacement for chlorine; as an ingredient in contact lens cleaning solution; and as a spoilage deterrent in paints and coatings. The registration mentioned above is for the use "as an agent to control the growth and action of microorganisms, and control generation of odors, on textiles such as cotton, cotton blends ... and cellulosic materials such as nonwovens, tissues, papers and pulps." It also states that REPUTEX® is "suitable for antimicrobial finishing" in textiles such as "household products, for example ... mops, dishcloths, yarns, cords and toweling."

The process is useful in treating paper used for making conventional paper money to render it antimicrobial to microorganisms which might be deposited thereon. Currency paper is a high-quality paper comprised largely of cotton and linen fibers, with addition of small amounts of other fibers to provide evidence of authenticity and discourage counterfeiting. It also incorporates additives to increase its strength and durability, particularly with respect to wet strength and durability to laundering.

Paper currency is subject to inadvertent laundering, e.g., when left in the pockets of garments that are washed, and is expected to survive such treatment at least once without being completely degraded and/or destroyed.

5 However, laundering, especially when both detergent and bleach are present in the wash water, is a severe test for any paper product including currency. It is believed that incorporation of PHMB into currency paper helps to resist the effect of laundering conditions especially when bleach,
10 particularly chlorine bleach, is present because PHMB tends to neutralize the action of the bleach.

Furthermore, because PHMB is strongly substantive to the cellulosic fibers of the paper, it is not readily removed by inadvertent soaking or laundering of the paper
15 currency.

The antimicrobial compound may be applied to the paper web in the process of the invention by any conventional procedure. For example, 1) addition to the pulp as the paper is manufactured, 2) saturation by immersion in a bath
20 containing the antimicrobial, 3) padding the web with a solution of the antimicrobial, 4) spraying the web with a solution of the antimicrobial, e.g., a 2 % solution in water, 5) coating the web with a coating material containing the antimicrobial, and 6) printing the web with an ink
25 containing the antimicrobial, are representative methods of applying the antimicrobial to the paper web. A preferred method of incorporating PHMB into currency paper is to add

the PHMB to glycerin used in an animal glue-glycerin surface sizing mixture applied to the currency paper, as discussed below.

When PHMB is applied as the antimicrobial, no special
5 temperature conditions are necessary. PHMB is substantive to the cellulose fibers of the paper and bonds to them essentially instantaneously on contact. After bonding to the fibers, PHMB is a durable antimicrobial and is expected to retain at least some its activity through laundering.

10 The amount of antimicrobial incorporated into the web is an amount that is effective to act as an antimicrobial agent, that is, an amount effective to inhibit the viability of microorganisms that might come into contact with the web. The treated paper web need not be immediately lethal to
15 microorganisms, but should not support the growth of microorganisms and should preferably reduce the number of viable microorganisms after challenge by inoculation with a test amount of microorganisms. The amount of antimicrobial agent to be applied can be readily determined by a
20 practitioner without undue experimentation. The efficacy of the antimicrobial treatment may be determined by a standard test such as the AATCC Method 100 or the U.S. Pharmacopoeia Preservative Effectiveness Test. An amount of antimicrobial agent should be incorporated into the currency paper to
25 render it sufficiently antimicrobial to pass such a conventional test. When PHMB is used as the antimicrobial agent, the amount applied may range from about 0.25 % to

about 3 % by weight of the total weight of the antimicrobial currency paper web.

When applied to currency paper PHMB is strongly bound to the linen and cotton fibers which constitute the web. In the last stages of its manufacture the currency paper is subjected to a surface sizing treatment in a sizing press. Any one of several conventional sizes may be applied in the surface sizing treatment, for example, an aqueous starch or modified starch size, an aqueous polyvinyl alcohol size, an aqueous animal glue size, or the like. It is preferred to apply the antimicrobial compound according to the process of the present invention in an aqueous surface size treatment of a currency paper web. In a preferred surface sizing treatment, a size comprising animal glue, plasticized with glycerin, is applied at a temperature of about 140°F (60°C). Accordingly, it is preferred to apply the PHMB to the currency paper in this animal glue-glycerin surface sizing step. The amount of glycerin used as a plasticizer in such an animal glue surface size is conventional and readily ascertainable by the skilled practitioner. This procedure causes the PHMB to be incorporated into the currency paper so that it will be absorbed throughout the surface layers of the web where it will be most effective against microorganisms coming into contact with the currency paper.

The currency paper prepared by the method of this invention is effective in inhibiting spread of infectious diseases when paper currency is exchanged by hand.

The invention having now been fully described, it should be understood that it may be embodied in other specific forms or variations without departing from its spirit or essential characteristics. Accordingly, the
5 embodiments described above are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims
10 are intended to be embraced therein.

WE CLAIM:

1 1. A process for preparing an antimicrobial currency
2 paper web comprising incorporating into a currency paper web
3 an amount of an antimicrobial compound effective to act as
4 an antimicrobial agent.

1 2. The process of Claim 1 wherein said antimicrobial
2 compound is substantive to said currency paper.

1 3. The process of Claim 1 wherein said antimicrobial
2 compound is selected from the group consisting of
3 chlorhexidine, polyhexamethylene biguanide, and water-
4 soluble salts of chlorhexidine and polyhexamethylene
5 biguanide.

1 4. The process of Claim 3 wherein said antimicrobial
2 compound is polyhexamethylene biguanide hydrochloride.

1 5. The process of Claim 1 wherein said antimicrobial
2 compound is applied to said currency paper web by immersing
3 said web in a solution of said antimicrobial compound.

1 6. The process of Claim 1 wherein said antimicrobial
2 compound is applied to said currency paper web by padding
3 said web with a solution of said antimicrobial compound.

1 7. The process of Claim 1 wherein said antimicrobial
2 compound is applied to said currency paper web by spraying
3 said web with a solution of said antimicrobial compound.

1 8. The process of Claim 1 wherein said antimicrobial
2 compound is applied to said currency paper web by
3 incorporating said antimicrobial compound into ink applied
4 to said paper web.

1 9. The process of Claim 1 wherein said antimicrobial
2 compound is polyhexamethylene biguanide hydrochloride
3 applied in solution with an aqueous surface sizing agent
4 applied to said currency paper web.

1 10. The process of Claim 9 wherein said aqueous
2 surface sizing agent is an animal glue size.

1 11. The process of Claim 10 wherein said animal glue
2 surface size incorporates glycerin as a plasticizer.

1 12. The process of Claim 1 wherein said antimicrobial
2 compound is polyhexamethylene biguanide hydrochloride,
3 applied in an amount of about 0.25 % to about 3 % by weight
4 of the total antimicrobial currency web weight.

1 13. An antimicrobial currency paper web prepared by
2 the process of Claim 1.

1 14. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is substantive to said
3 currency paper.

1 15. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is selected from the
3 group consisting of chlorhexidine, polyhexamethylene
4 biguanide, and water-soluble salts of chlorhexidine and
5 polyhexamethylene biguanide.

1 16. The antimicrobial currency paper web of Claim 15
2 wherein said antimicrobial compound is polyhexamethylene
3 biguanide hydrochloride.

1 17. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is applied by immersing
3 said currency paper web in a solution of said antimicrobial
4 compound.

1 18. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is applied by padding
3 said currency paper web with a solution of said
4 antimicrobial compound.

1 19. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is applied by spraying
3 said currency paper web with a solution of said
4 antimicrobial compound.

1 20. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is applied by
3 incorporating said antimicrobial compound into ink applied
4 to said currency paper web.

1 21. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is polyhexamethylene
3 biguanide hydrochloride applied in solution with an aqueous
4 surface sizing agent applied to said currency paper web.

1 22. The antimicrobial currency paper web of Claim 21
2 wherein said aqueous surface sizing agent is an animal glue
3 size.

1 23. The antimicrobial currency paper web of Claim 22
2 wherein said animal glue surface size incorporates glycerin
3 as a plasticizer.

1 24. The antimicrobial currency paper web of Claim 13
2 wherein said antimicrobial compound is polyhexamethylene
3 biguanide, applied in an amount of about 0.25 % to about 3 %
4 by weight of the total antimicrobial currency paper web
5 weight.

6 25. An antimicrobial currency paper web comprising
7 currency paper and an amount of an antimicrobial compound
8 selected from the group consisting of chlorhexidine,
9 polyhexamethylene biguanide, and water-soluble salts of
10 chlorhexidine and polyhexamethylene biguanide effective to
11 act as an antimicrobial agent.

1 26. The antimicrobial currency paper web of Claim 25
2 wherein said antimicrobial compound is polyhexamethylene
3 biguanide hydrochloride.

1 27. The antimicrobial currency paper web of Claim 25
2 wherein said antimicrobial compound is polyhexamethylene
3 biguanide hydrochloride present in amount of from about
4 0.25 % by weight to about 3 % by weight of the total weight
5 of the antimicrobial currency paper web.

1 28. A method of inhibiting spread of infectious
2 diseases comprising treating paper currency to be exchanged
3 by hand with an amount of an antimicrobial compound
4 effective to act as an antimicrobial agent.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/03698

A. CLASSIFICATION OF SUBJECT MATTER IPC(6) :D21H 21/36; D21F 11/00; G07D 7/00 US CL :162/140, 161, 158, 168.2; 442/123; 427/395, 391, 2.31 According to International Patent Classification (IPC) or to both national classification and IPC																										
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) U.S. : 162/140, 161, 158, 168.2; 442/123; 427/395, 391, 2.31; 428/913; 283/72 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) APS, DERWENT, DIALOG currency, safety, security, paper, micro?, bioci?, fungic?, slime?, virus?, bacter?, anti-microbi?																										
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>Database Papechem on Dialog, No. AB5603091, Bomar, M. T.;</td> <td>1-2, 13-14</td> </tr> <tr> <td>--</td> <td>Muller, H. "Germ-Free Banknotes with Chemical Bonded</td> <td>-----</td> </tr> <tr> <td>Y</td> <td>Disinfectants" abstract, Papier 39, no. 3. pp 110-114, March 1985.</td> <td>3-12, 15-28</td> </tr> <tr> <td>Y</td> <td>US 4,837,079 A (QUANTRILLE et al) 06 June 1989, see entire document.</td> <td>1-28</td> </tr> <tr> <td>Y</td> <td>US 4,929,498 A (SUSKIND et al) 29 May 1990, see entire document.</td> <td>1-28</td> </tr> <tr> <td>A</td> <td>US 4,814,334 A (SALKIN) 21 March 1989, see entire document.</td> <td>1-28</td> </tr> <tr> <td>A</td> <td>US 1,839,995 A (REMICK) 05 January 1932, see whole document.</td> <td>1-28</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	Database Papechem on Dialog, No. AB5603091, Bomar, M. T.;	1-2, 13-14	--	Muller, H. "Germ-Free Banknotes with Chemical Bonded	-----	Y	Disinfectants" abstract, Papier 39, no. 3. pp 110-114, March 1985.	3-12, 15-28	Y	US 4,837,079 A (QUANTRILLE et al) 06 June 1989, see entire document.	1-28	Y	US 4,929,498 A (SUSKIND et al) 29 May 1990, see entire document.	1-28	A	US 4,814,334 A (SALKIN) 21 March 1989, see entire document.	1-28	A	US 1,839,995 A (REMICK) 05 January 1932, see whole document.	1-28
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